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Original Article

Prevalence and Associated Risk Factors of the Metabolic Syndrome in the Korean Workforce

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Abstract: The purposes of this study were to estimate the prevalence of metabolic syndrome and to investigate the risk factors associated with metabolic syndrome in Korean workers. This is a secondary data analysis study using the data set from the Korean National Health and Nutrition Examination Survey IV. A total of 1,545 workers over 20 yr of age were included in this analysis. The prevalence of metabolic syndrome was determined using the modified National Cholesterol Education Program Adult Treatment Panel III criteria. Waist circumference was based on the study of obesity guidelines. The overall prevalence of metabolic syndrome among Korean workers was 21.0% (28.5% men, 11.8% women). In a multiple logistic regression analysis, male workers with high job control and heavy alcohol consumption were significantly associated with metabolic syndrome. For women, low job control and current smoking increased the risk of metabolic syndrome. The risk of developing metabolic syndrome is strongly associated with level of job control in both male and female workers. These findings suggest that behavioral lifestyle modifications, including smoking cessation, moderating alcohol consumption, and controlling work-related factors and job control in the workplace should be considered for the prevention and management of metabolic syndrome in Korean workers.

Key words: Occupational epidemiology, Work environments, Cardiovascular disorders, Psychosocial stress, Metabolic syndrome

Introduction

Metabolic syndrome is a clustering of risk factors known to increase the onset of diabetes and subsequent cardiovascular disease (CVD)[1)]. According to previous studies, patients diagnosed with metabolic syndrome had two to five times the risk of developing CVD compared to the general population[2)]. The diagnosis of metabolic syndrome identifies a population at high risk of CVD[3, 4)]. In the present study, metabolic syndrome was defined according to the modified National Cholesterol Education Panel Adult Treatment Panel III (NCEP ATP III)[5, 6)]. The definition of metabolic syndrome was based on the presence of three or more of the following signs: (1) waist circumference (WC) ≥90 cm for men or ≥85 cm for women (Korean Society for the Study of Obesity guidelines for WC)[7)], (2) triglycerides (TG) levels ≥150 mg/dl, (3) high-density lipoprotein cholesterol (HDL-C) levels, ≤40 mg/dl for men or ≤50 mg/dl for women, (4) hypertension, defined as systolic blood pressure (BP) ≥130 mmHg, diastolic BP ≥85 mmHg, or if the subject was under active antihypertensive drug therapy, and (5) fasting blood glucose (FBG)

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≥100 mg/dl, or if the subject was actively using oral antidiabetic medication or insulin.

Many prior studies have shown that the prevalence rate of metabolic syndrome in the general population varies by age and ethnicity[2, 8, 9]. The overall prevalence of metabolic syndrome ranges from 6% to 30% of the general population in the United States, Europe, and Asia, including Korea[9, 10]. But, there is no uniform accepted definition of metabolic syndrome, and it is difficult to compare the prevalence of metabolic syndrome across nations and studies. Moreover, although the prevalence of metabolic syndrome has been reported extensively in various age groups in Korea, little is known about its prevalence and the risk factors among working adults on the basis of nationally representative populations.

The predominant underlying risk factors for metabolic syndrome appear to be abdominal obesity and insulin resistance[5]. In particular, obesity is generally recognized as an increasingly important cause of metabolic syndrome[2, 4]. Also, behavioral lifestyle factors such as smoking, alcohol consumption, poor dietary habits, and sedentary lifestyles are closely associated with the prevalence of metabolic syndrome[2, 10, 11]. Physical inactivity, aging, education level, immigrant status, and hormone imbalance are also known factors associated with metabolic syndrome[1, 4, 12, 13]. Nevertheless, up to now, there has been no clear consensus about the cause or risk factors related to the incidence of metabolic syndrome. In particular, work-related factors as risk factors for metabolic syndrome in workers have not been studied. Recently, the risk of metabolic syndrome has increased gradually in many workplaces. Night shift work, which affects circadian rhythms, may be a factor[14]. But these studies have been limited to Western countries, infrequently studied among Asians, and focused on specific job categories such as blue collar workers and office workers[15, 16].

Despite the high prevalence of metabolic syndrome, metabolic risk factors and the distribution of these factors by gender in Korean workers are still unknown compared to workers of other countries[11, 17]. Therefore, we aim to investigate the prevalence of metabolic syndrome and associated risk factors, such as work-related characteristics in Korean workers through the Korean National Health and Nutrition Examination Survey (KNHANES).

Methods

Design and data source

This is a secondary data analysis study using the KNHANES, which was conducted from April to June 2007 by the Korean Ministry of Health and Welfare. The KNHANES IV collected data from a representative sample of Koreans using a stratified, multistage probability sampling design based on 2005 census data[18]. The urban and rural areas of 29 administrative districts were first taken as strata. From the strata, 200 national districts were taken as primary sampling units based on proportional random sampling. Lastly, 20–23 households were sampled from each unit, and all family members older than 1 yr of age in the selected households took part in the KNHANES. The survey consisted of the following four components: a health interview survey, a health behavior survey, a health examination survey, and a nutrition survey.

The targeted population for the survey consisted of 34,145 individuals older than 1 yr of age. In total, 33,848 individuals completed the interview. The response rate was 99.1% of 10,816 participants who underwent blood tests; 7,597 subjects (70.2%) aged 1 yr and older completed the survey. 2,037 persons with work more than 20 yr were identified by a positive response to the question, "Did you work at a job or business last week?" It included Korean workers who were wageworkers, owners or employers, and volunteer workers for the family. Three hundred thirty-six workers had one or two items missing on questionnaires. Those with missing data did not differ from those without missing data in terms of demographics and work-related characteristics. We excluded individuals with incomplete data for the standardized physical examination, blood tests, and anthropometric measures. In addition, twenty-six pregnant women were excluded. This resulted in a final analytical sample of 1,545 workers (858 men and 687 women) aged 20 yr or older.

Ethical aspects

The original survey and informed consent was approved by the Korea Centers for Disease Control and Prevention (KCDC) institutional review board. Informed consent was obtained from subjects. This study used only non-identified existing data with no subject personal information. Permission to conduct this study was approved by the ethics committee of University. The SPSS data set and the data directory were directly downloaded from the KCDC website (http://knhanes.cdc.go.kr/), and downloaded electronic data was protected by password.

Measurements

Data Characteristics and Diagnostic Criteria of Metabolic Syndrome

The socio-demographic factors used in this study were age, gender, education, economic sector, and occupational class. Occupational class was determined based on the Korean Standard Classification of Occupations[19]. Managers, professionals, office workers, and related workers were classified as "white collar worker." Sales, agricultural, assembly, and fishing workers were classified as "skilled blue collar." Simple laborers were classified as "non-skilled blue collar."

Work-related factors included type of shift work, overtime work, job demand, job control, and job support. Type of shift work was determined by a "yes" or "no" question. Overtime work was divided into two groups using a cut-off of 60 h per wk. The level of job demand, control, and support were classified using a single-item questionnaire, respectively. "Does your job require time straining at the worksite?, "Do you have control or influence in the worksite?, and "Do you have support from others at the worksite?" For each item, the respondents chose one of four Likert options: "strongly agree," "agree," "disagree," or "strongly disagree." In this study, "strongly agree" and "agree" were classified as high level, and "disagree" and "strongly disagree" were classified as low level.

Behavioral lifestyle factors included: physical exercise, current smoking, heavy alcohol consumption, and eating out. Physical exercise was defined as exercising for 30 min more than 3 times per week. "Current smokers" were defined as participants who smoked at least one cigarette per day. "Never smokers" were defined as participants who had never tried a cigarette in their lives. "Former smokers" were defined as participants who had stopped smoking over one year ago. Never smokers and former smokers were classified as "non-smoking" in this study. Heavy alcohol consumption was classified with "yes" or "no" response according to the dietary guidelines advisory committee. The definition of a heavy alcohol drinker was calculated by the quantity and frequency of alcohol consumption. Heavy drinkers were defined as those who drink more than five drinks at any one sitting once a wk or more[20]. Eating out was defined as having a meal outside of the home more than three times per wk.

Systolic and diastolic BP was measured using standardized techniques and equipment. After five min of rest while seated, BP was measured three times, with 30 s intervals, using a standard mercury sphygmomanometer. The average of the second and third measurements was used in the analysis. Body mass index (BMI) was calculated by dividing weight by height squared (kg/m^2). We categorized study subjects according to BMI criteria obtained from World Health Organization recommendations for Asians[21]: normal (<23 kg/m^2), overweight (23–24.9 kg/m^2) and obesity (≥25 kg/m^2). Using a fiberglass tape measure, WC was measured at the midpoint between the bottom of the rib cage and the top of the iliac crest. Blood samples were collected in the morning after fasting for at least eight h. FBG, TC, TG, and HDL-C levels were measured in a certified laboratory.

Statistical analysis

Data were analyzed using SPSS version 17.0 (SPSS Inc., Chicago, IL, USA) statistical software program. The χ^2 test was used to test for differences between categorical data. Three multiple logistic regressions were performed to examine the determinants of metabolic syndrome by gender among socio-demographic variables and job characteristics, work-related factors, and behavioral lifestyle factors. Work-related factors included job demand, job control, and job support, as well as combined variables included in multivariate analyses. The final regression, including all three factors, was created for men and used to estimate odds ratios (OR).

To estimate population-based results, sampling weights were applied for the diagnosis of metabolic syndrome, so the estimates were representative of male and female Korean workers. Weighted numbers were presented to describe the number of those with metabolic syndrome. Adjustments were made for all independent variables. All reported *p*-values were two-tailed, and confidence intervals were calculated at the 95% level. A *p*-value of less than 0.05 was considered significant.

Results

Socio-demographic, work-related, and behavioral lifestyle characteristics by gender

The 1,545 employees studied included 858 men and 687 women, with mean ages of 46.18 and 46.44 yr, respectively. The socio-demographics and job characteristics, work-related and behavioral lifestyle factors of Korean workers by gender are presented in Table 1. The study found that male workers were better educated, had a higher prevalence of obesity, with more shift work, more overtime work, and more control of their job than women. Also, the men drank more alcohol and smoked more frequently than women. More of the female workers (69.7%) were in

Table 1. Sociodemographic, work-related factors, and behavioral lifestyle characteristics of Korean workers by gender (n= 1,545, Weighted n = 15,991,186)

Characteristics	Categories	Total (n=1,545)	Men (n=858)	Women (n=687)	χ^2	*p*
			n (%)	n (%)		
Age (yr)	20–29	162 (10.5)	79 (9.2)	83 (12.2)	6.8	0.148
	30–39	394 (25.5)	231 (26.9)	163 (23.7)		
	40–49	401 (25.9)	229 (26.7)	172 (25.0)		
	50–59	300 (19.5)	170 (19.8)	130 (18.9)		
	≥60	288 (18.6)	149 (17.4)	139 (20.2)		
Level of education	Middle school or less	548 (35.5)	250 (29.1)	298 (43.4)	35.2	<0.001
	High school	517 (33.5)	306 (35.7)	211 (30.7)		
	College or over	480 (31.0)	302 (35.2)	178 (25.9)		
Body mass index	Normal	642 (41.6)	296 (34.6)	346 (50.4)	39.61	<0.001
	Overweight	404 (26.1)	245 (28.6)	159 (23.2)		
	Obesity	499 (32.3)	317 (36.8)	182 (26.4)		
Economic sector	Non-service	621 (40.2)	422 (49.2)	199 (30.3)	54.2	<0.001
	Service	894 (57.8)	436 (50.8)	458 (69.7)		
Type of occupation	White collar	512 (33.1)	287 (33.4)	225 (32.7)	1.15	0.563
	Skilled blue collar	727 (47.1)	410 (47.8)	317 (46.3)		
	Non-skilled blue collar	306 (19.8)	161 (18.8)	145 (21.0)		
Shift work	No	1,178 (76.2)	634 (73.9)	544 (79.2)	5.9	0.015
	Yes	367 (23.8)	224 (26.1)	143 (20.8)		
Overtime work (≥60 hr/wk)	No	1,185 (76.7)	622 (72.5)	563 (81.9)	19.1	<0.001
	Yes	360 (23.3)	236 (27.5)	124 (18.1)		
Job demand	Low	913 (59.1)	534 (62.3)	379 (55.2)	7.81	0.005
	High	632 (40.9)	324 (37.7)	308 (44.8)		
Job control	Low	344 (22.3)	147 (17.1)	197 (28.7)	29.44	<0.001
	High	1,201 (77.7)	711 (82.9)	490 (71.3)		
Job support	Low	148 (9.6)	79 (9.2)	69 (10.1)	0.34	0.562
	High	1,397 (90.4)	779 (90.8)	618 (89.9)		
Physical exercise (≥30 min, ≥3/wk)	No	1,446 (93.6)	794 (92.6)	652 (95.0)	3.76	0.052
	Yes	98 (6.4)	63 (7.4)	35 (5.0)		
Heavy alcohol consumption	No	766 (49.6)	299 (34.8)	467 (68.0)	167.5	<0.001
	Yes	779 (50.4)	559 (65.2)	220 (32.0)		
Current smoking	No	1,125 (72.8)	465 (54.2)	660 (96.2)	34.32	<0.001
	Yes	420 (27.2)	393 (45.8)	27 (3.8)		
Out eat	No	1,042 (67.4)	513 (59.8)	529 (77.0)	44.59	<0.001
	Yes	503 (32.6)	345 (40.2)	158 (23.0)		

service jobs than male counterparts. The female workers showed higher job demand than male workers.

Prevalence of metabolic syndrome

The sample of this study represents 15,991,186 Korean workers including 10,489,234 men and 5,501,951 women older than 20 yr. Table 2 shows the distribution of metabolic syndrome among Korean male and female workers, based on the NCEP ATP III guideline. Around 26% of the Korean working population was categorized as having metabolic syndrome, 74.2% with non-metabolic syndrome.

The prevalence of each component of metabolic syndrome and the clustering of metabolic syndrome are shown in Table 3. Overall, the prevalence of metabolic syndrome among Korean workers was 21.0%. Of note, metabolic syndrome was more common among men (28.5%) than women (11.8%). Male workers had a higher prevalence of abdominal obesity, higher BP, higher FBG, higher TG, and a clustering of three or more of the compo-

Table 2. Distribution of metabolic syndrome in population-based Korean workers

Metabolic syndrome	Total (n=1,545) Weighted n (%)	Men (n=858) Weighted n (%)	Women (n=687) Weighted n (%)
Diagnosis of metabolic syndrome ≥3	4,124,858 (25.8%)	3,062,131 (29.2%)	1,062,727 (19.3%)
Non-diagnosis of metabolic syndrome <3	11,866,327 (74.2%)	7,427,103 (70.8%)	4,439,224 (80.7%)
Total	15,991,186 (100%)	10,489,234 (100%)	5,501,951 (100%)

Missing: 4,455,693.

Table 3. Prevalence of metabolic syndrome and its clustering of components among Korean workers by gender

Components of metabolic syndrome		Total (n=1,545) n (%)	Men (n=858) n (%)	Women (n=687) n (%)	χ^2	*p*
HDL-C <40 mg/dL (Men), 50 (Women)		995 (64.4)	504 (60.8)	491 (72.7)	79.8	<0.001
TG ≥ 150 mg/dL		437 (29.1)	315 (38.0)	122 (18.1)	71.64	<0.001
WC ≥ 90 cm (Men), 85 (Women)		409 (26.5)	231 (37.2)	178 (26.1)	46.1	<0.001
FBG ≥ 100 mg/dL		329 (21.5)	219 (25.6)	110 (16.2)	20.01	<0.001
BP ≥ 130/85 mmHg		194 (12.6)	267 (31.1)	125 (18.2)	33.3	<0.001
Number of Metabolic Syndrome	0	227 (14.7)	83 (9.7)	144 (21.0)	0.01	0.955
Components*	1	607 (39.3)	251 (29.3)	322 (46.9)	15.14	<0.001
	2	451 (29.2)	215 (25.1)	133 (19.4)	21.57	<0.001
	3	204 (13.2)	144 (16.8)	60 (8.7)	21.57	<0.001
	4	95 (6.1)	77 (9.0)	17 (2.5)	26.69	<0.001
	5	26 (1.7)	23 (2.7)	4 (1.3)	11.6	<0.001
Diagnosis of metabolic syndrome	≥3	325 (21.0)	244 (28.5)	81 (11.8)	63.66	<0.001

BP; blood pressure, FBG; fasting blood glucose, HDL-C; high-density lipoprotein cholesterol, TG; triglyceride, WC; waist circumference. *Fisher's exact-test.

nents of metabolic syndrome, whereas female workers had a higher prevalence of low HDL-C levels.

Associated risk factors for metabolic syndrome

Tables 4 and 5 show the results from multivariate analyses adding the adjusted OR for associations between socio-demographics and job characteristics (Model 1), work-related factors (Model 2), behavioral lifestyles (Model 3), and the risk of metabolic syndrome in men and women, respectively. Two variables of Model 3 remained statistically significant, adjusting for all other variables.

In Model 3, the adjusted OR results suggested that high job control (OR=2.32; 95%CI=1.17–4.61) and heavy alcohol consumption (OR=2.17, 95%CI=1.37–3.45) predict risk of metabolic syndrome in male workers. For women, low job control (OR=0.44, 95%CI=0.23–0.86) and current smoking (OR=3.97, 95%CI=1.09–14.44) were significantly associated with risk of metabolic syndrome.

Discussion

This study shows that 21.0% of Korean workers can be classified as having metabolic syndrome. The prevalence of metabolic syndrome is higher in male workers (28.5%) than in female workers (11.8%). To our knowledge, little research has been done to estimate the incidence of metabolic syndrome in the same age group in a Western working population based on national survey. In addition to the characteristics of the study sample, the diversity of metabolic syndrome definitions across studies could also be responsible for the inconsistent estimates of metabolic syndrome prevalence in previous studies[3, 5]. Despite that fact, compared with the general population of similar age, the prevalence of metabolic syndrome in previous studies ranged from 18.5% to 24.9% in men and 5.2% to 11.7% in women[2, 3]. Prior results suggest that the prevalence of metabolic syndrome in Korean workers may be slightly higher than that of the general population. The incidence of metabolic syndrome is also higher than the working population of men in only the 30–39 yr range[22, 23]. Furthermore, the prevalence of metabolic syndrome in Korean workers is higher than in Thai professionals and office workers, with rates among men at 25.8%, and for women at 8.2%[9]. In contrast, Shultz and Edington found that 30.2% of employees at a Midwestern U.S. manufacturing company met the criteria for metabolic syndrome[16]. This

Table 4. Associated factors of the metabolic syndrome in men using multiple logistic regression

Variables	Categories	Crude OR (95%CI)	*p*	Model 1		Model 2		Model 3*	
				Adjusted OR (95%CI)	*p*	Adjusted OR (95%CI)	*p*	Adjusted OR (95%CI)	*p*
Age (yr)	20–29	1.00	.	1.00	.	1.00	.	1.00	.
	30–39	0.77 (0.59–1.00)	0.051	2.47 (1.11–5.51)	0.027	1.76 (0.56–5.58)	0.335	1.79 (0.52–6.11)	0.570
	40–49	1.42 (0.33–6.16)	0.637	3.08 (1.09–8.69)	0.033	3.15 (1.03–9.62)	0.044	1.58 (0.33–7.64)	0.354
	50–59	1.32 (0.20–8.66)	0.774	2.70 (0.69–10.51)	0.153	2.35 (0.67–8.18)	0.180	1.48 (0.19–11.29)	0.707
	≥60	0.73 (0.06–9.31)	0.805	1.89 (0.30–11.99)	0.499	2.20 (0.57–8.59)	0.255	0.96 (0.06–14.82)	0.979
Level of education	Middle school or less	1.00		1.00		1.00		1.00	
	High school	0.84 (0.62–1.15)	0.268	0.69 (0.45–1.06)	0.091	0.33 (0.14–0.79)	0.012	0.61 (0.34–1.12)	0.110
	College or over	0.86 (0.63–1.18)	0.351	0.59 (0.36–0.98)	0.04	0.39 (0.14–1.05)	0.061	0.55 (0.27–1.15)	0.114
Economic sector	Non-service	1.00		1.00		1.00		1.00	
	Service	0.98 (0.72–1.33)	0.898	1.18 (0.87–1.60)	0.292	1.55 (0.88–2.72)	0.126	0.99 (0.64–1.54)	0.963
Type of occupation	White collar	1.00		1.00		1.00		1.00	
	Skilled blue collar	0.87 (0.64–1.17)	0.350	0.66 (0.46–0.97)	0.032	0.69 (0.34–1.38)	0.294	0.75 (0.44–1.29)	0.300
	Non-skilled blue collar	0.77 (0.52–1.14)	0.189	0.59 (0.37–0.96)	0.032	0.46 (0.18–1.16)	0.099	0.77 (0.36–1.63)	0.487
Physical Exercise ≥30 min, ≥3/wk	No	1.00				1.00	–	1.00	
	Yes	0.92 (0.52–1.64)	0.774			1.22 (0.62–2.42)	0.566	0.79 (0.37–1.70)	0.548
Heavy alcohol consumption	No	1.00				1.00	–	1.00	
	Yes	1.56 (1.13–2.16)	0.007			1.48 (0.81–2.73)	0.207	2.17 (1.37–3.45)	0.001
Current smoking	No	1.00				1.00	–	1.00	
	Yes	0.62 (0.80–1.45)	0.623			1.02 (0.58–1.78)	0.957	1.35 (0.87–2.11)	0.183
Out eat	No	1.00				1.00	–	1.00	
	Yes	0.85 (0.61–1.19)	0.351			1.10 (0.61–1.96)	0.761	0.91 (0.59–1.42)	0.698
Job support	Low	1.00		–	–			1.00	
	High	1.77 (0.99–3.17)	0.056	–	–			0.93 (0.41–2.13)	0.863
Shift work	No	1.00		–	–			1.00	
	Yes	0.84 (0.60–1.19)	0.326	–	–			1.01 (0.61–1.68)	0.976
Overtime work (≥60 h/wk)	No	1.00		–	–			1.00	
	Yes	1.12 (0.80–1.55)	0.51	–	–			0.87 (0.54–1.42)	0.576
Job demand	Low	1.00		–	–			1.00	
	High	0.88 (0.65–1.20)	0.425	–	–			0.98 (0.63–1.54)	0.943
Job control	Low	1.00		–	–			1.00	
	High	1.86 (1.19–2.89)	0.006	–	–			2.32 (1.17–4.61)	0.016
Job support	Low	1.00		–	–			1.00	
	High	1.77 (0.99–3.17)	0.056	–	–			0.93 (0.41–2.13)	0.863

* The final regression model including all variables in Model 3 was created for men and used to estimate the odds ratios.

Table 5. Associated factors of the metabolic syndrome in women using multiple logistic regression

Variables	Categories	Crude OR (95%CI)	*p*	Model 1		Model 2		Model 3	
				Adjusted OR (95%CI)	*p*	Adjusted OR (95%CI)	*p*	Adjusted OR (95%CI)	*p*
Age (yr)	20–29	1.00	.	1.00		1.00	.	1.00	.
	30–39	0.27 (0.15–0.51)	<0.001	0.97 (0.29–3.24)	0.953	0.38 (0.02–7.96)	0.536	0.92 (0.16–5.31)	0.928
	40–49	0.66 (0.41–1.07)	0.091	1.63 (0.39–6.84)	0.504	3.14 (0.25–39.77)	0.377	0.86 (0.10–7.32)	0.887
	50–59	1.61 (1.03–2.12)	0.038	2.50 (0.42–15.01)	0.316	3.15 (0.18–55.53)	0.434	0.54 (0.04–8.16)	0.658
	≥60	4.13 (2.72–6.27)	<0.001	4.18 (0.40–43.28)	0.230	11.70 (0.59–230.50)	0.106	0.85 (0.03–27.76)	0.929
Level of education	Middle school or less	1.00		1.00		1.00		1.00	
	High school	0.81 (0.61–1.08)	0.159	0.72 (0.36–1.43)	0.347	0.87 (0.18–4.35)	0.869	0.62 (0.23–1.64)	0.331
	College or over	0.31 (0.18–0.56)	<0.000	0.64 (0.25–1.66)	0.358	0.35 (0.03–4.04)	0.397	0.93 (0.24–3.67)	0.922
Economic sector	Non-service	1.00		1.00		1.00		1.00	
	Service	0.59 (0.39–0.87)	0.009	1.14 (0.70–1.87)	0.601	1.26 (3.33–4.81)	0.737	0.83 (0.42–1.64)	0.587
Type of occupation	White collar	1.00		1.00		1.00		1.00	
	Skilled blue collar	2.35 (0.85–1.83)	0.254	0.93 (0.43–1.98)	0.840	0.52 (0.09–3.10)	0.469	0.58 (0.19–1.82)	0.353
	Non-skilled blue collar	2.22 (1.45–3.39)	<0.001	1.26 (0.56–2.84)	0.581	1.29 (0.19–8.82)	0.802	1.19 (0.36–3.97)	0.772
Physical Exercise	No	1.00		–		1.00	–	1.00	
≥30 min, ≥3/wk	Yes	2.86 (0.63–12.92)	0.173	–		3.26 (0.61–17.49)	0.168	0.97 (0.28–3.49)	0.973
Heavy alcohol	No	1.00				1.00	–	1.00	
consumption	Yes	0.77 (0.51–1.18)	0.241			0.80 (0.22–2.88)	0.732	1.55 (0.81–2.98)	0.187
Current smoking	No	1.00				1.00	–	1.00	
	Yes	1.96 (0.83–4.61)	0.123			1.49 (0.12–18.87)	0.756	3.97 (1.09–14.44)	0.036
Out eat	No	1.00				1.00	–	1.00	
	Yes	0.66 (0.40–1.11)	0.114			1.88 (0.45–7.85)	0.388	1.09 (0.51–2.37)	0.819
Shift work	No	1.00		–				1.00	
	Yes	0.84 (0.60–1.19)	0.326	–				0.42 (0.18–1.02)	0.055
Overtime work	No	1.00		–				1.00	
(≥60 h/wk)	Yes	1.03 (0.73–1.69)	0.892	–				1.07 (0.47–2.47)	0.868
Job demand	Low	1.00		–				1.00	
	High	1.53 (1.05–2.26)	0.028	–	–			1.39 (0.76–2.55)	0.283
Job control	Low	1.00		–	–			1.00	
	High	0.73 (0.49–1.10)	0.135	–	–			0.44 (0.23–0.86)	0.016
Job support	Low	1.00		–	–			1.00	
	High	0.63 (0.35–1.13)	0.120	–	–			0.84 (0.37–1.93)	0.684

* The final regression model including all variables in Model 3 was created for women and used to estimate the odds ratios.

difference could be due to sample size, type of occupation, or ethnicity. However, over the past several decades, Korea has experienced rapid socioeconomic growth resulting in lifestyle changes. The Westernization of lifestyle, such as the combination of a relatively high fat and simple carbohydrate diet with low physical activity in Korean adults seem to have contributed to the high incidence of metabolic syndrome[10]. Furthermore, this may be attributed to difficulty accessing medical services or practicing healthier lifestyle habits in the workplace[16]. This remarkable disparity in the prevalence of metabolic syndrome by gender might be explained by socioeconomic and lifestyle differences between genders[16]. Male workers had higher levels of physical activity at work, consumed more alcohol, smoked substantially more cigarettes and preferred to eat outside. On the other hand, female workers were primarily employed in non-shift work and had less overtime work[15].

In this study, we found that the adjusted odds ratio was associated with job control in both male and female workers, and that job control was the work-related factor among associated factors for metabolic syndrome. However, male workers with self-perceived higher levels of job control had an increased risk of metabolic syndrome. In contrast, women with self-perceived lower job control were at increased risk of metabolic syndrome. Job control is the belief a person has that he or she can control events and circumstances surrounding his/her job requirement[24]. Accordingly, low perceived control in the job context is having a limited ability to influence job tasks that impact the working environment[12, 25]. In previous studies, the most consistent work organization feature associated with CVD was low job control[1, 24]. However, empirical support for the relationship between low job control and metabolic syndrome has not been established in various populations[26]. Furthermore, the present study shows that job control has the opposite effect on the prevalence of metabolic syndrome in men and women.

Recently, there has been an increase in participation in the workforce of Korean women. Korean women have also shown more progress than other women of color in attaining higher-level positions in the workforce. Despite these changes, Korean women still receive fewer opportunities for promotion. Furthermore, women are assigned to unimportant responsibilities and are provided little training related to job control[27]. Men have more responsibility and obligations at work and home than women[24]. Consequently, men may experience additional job stress. Given that the effect of job control appears to be different for men and women, a statistical model with an interaction term was created and further supports that this difference exists. These findings show that Korean male and female workers are different from each other in their perception of job control. For this reason, future longitudinal research should be conducted exploring the relationship between metabolic syndrome and various work-related characteristics by gender worldwide.

Current smoking was found to be a significant independent risk factor for metabolic syndrome in women, while smoking status was not significantly associated with risk of metabolic syndrome in men. These findings are similar to those from previous cross-sectional studies[1, 12]. Smokers have been shown to be hyperinsulinemic and dyslipidemic compared with a matched group of non-smokers[10]. Cigarette smoking may also induce an increase in abdominal obesity[1]. Current smoking has almost no impact in the prevalence of metabolic syndrome, as it is not associated with male workers and is only present among 3.8% of females, thus its effect in the studied population is almost negligible.

On the other hand, heavy alcohol consumption compared to slight or moderate alcohol consumption has been found to be associated with metabolic syndrome in men. This finding is consistent with results from previous studies, in which heavy alcohol consumption had negative effects on HDL-C levels and BP[10]. Therefore, measure to prevent stress at work can have a positive impact on work-related risk factors such as current smoking and heavy alcohol consumption, which are partially related to job stress[28].

In this study, shift work tends to be protective of metabolic syndrome among women. This result can be explained by the healthy worker effect, which refers to a phenomenon observed initially in occupational studies, which might make it more difficult to observe risk factors, particularly in prevalence studies[29].

Several limitations of this study should be acknowledged. First, it was a cross-sectional analysis, so causal inferences cannot be made. As we know, the cross-sectional study design does not allow us to determine the directionality of observed association. This may be a concern of methodological weakness in this study. Second, the risk factors regarding working condition had not been examined comprehensively, so we conducted a self-report questionnaire to assess the level of job demand, control, and support, which does not include any criteria pertaining to the psychometric characteristic of this scale. A word of warning should be considered on this result until con-

firmed by other studies. However, this item was also used in another nationwide study and had a significant effect on the working population[30]. Third, it did not assess detailed work-related characteristics, including psychological aspects or history of lifestyle patterns. Finally, current smoking percentage was lower in women than that of men, as well as in the general population, which may lead to different results between male and female workers.

Despite these limitations, this is the first study to identify the associated factors with metabolic syndrome, sociodemographic characteristics, work-related factors, and behavioral lifestyle factors among Korean workforce. This study will serve as a reference for designing future health-promotion programs in the workplace. Furthermore, we believe that our study provides important new insights into the effects of work characteristics on worker health by gender.

Conclusion

The prevalence of metabolic syndrome in this Korean working population was common, especially among men, and those with increased level of job control and with unhealthy lifestyles such as current smoking and heavy alcohol consumption. Therefore, it is strongly suggested that lifestyle modification, such as smoking cessation and reducing alcohol consumption, should be made for those who are at risk of metabolic syndrome. Specifically, industrial health promotion management is needed regarding job control in the workplace. Further research is needed to identify the prevalence of metabolic syndrome and its work-related factors using comprehensive measures in various occupational sectors.

References

1) Malik S, Wong ND (2009) Metabolic syndrome, cardiovascular risk and screening for subclinical atherosclerosis. Expert Rev Cardiovasc Ther **7**, 273–80.
2) Ferrari CB (2008) Metabolic syndrome and obesity: epidemiology and prevention by physical activity and exercise. J Exerc Sci Fit **6**, 87–96.
3) Choi KM, Kim SM, Kim YE, Choi DS, Baik SH, Lee J (2007) Prevalence and cardiovascular disease risk of the metabolic syndrome using National Cholesterol Education Program and International Diabetes Federation definitions in the Korean population. Metabolism **56**, 552–8.
4) Galassi A, Reynolds K, He J (2006) Metabolic syndrome and risk of cardiovascular disease: a meta-analysis. Am J Med **119**, 812–9.
5) Grundy SM, Cleeman JI, Daniels SR, Donato KA, Eckel RH, Franklin BA, Gordon DJ, Krauss RM, Savage PJ, Smith SC Jr, Spertus JA, Costa F (2005) Diagnosis and management of the metabolic syndrome: an American Heart Association/National Heart, Lung, and Blood Institute Scientific Statement. Circulation **112**, 2735–52.
6) (2001) Executive Summary of The Third Report of The National Cholesterol Education Program (NCEP) Expert Panel on Detection, Evaluation, And Treatment of High Blood Cholesterol In Adults (Adult Treatment Panel III). JAMA **285**, 2486–97.
7) Lee SY, Park HS, Kim DJ, Han JH, Kim SM, Cho GJ, Kim DY, Kwon HS, Kim SR, Lee CB, Oh SJ, Park CY, Yoo HJ (2007) Appropriate waist circumference cutoff points for central obesity in Korean adults. Diabetes Res Clin Pract **75**, 72–80.
8) Hu D, Fu P, Xie J, Chen CS, Yu D, Whelton PK, He J, Gu D (2008) Increasing prevalence and low awareness, treatment and control of diabetes mellitus among Chinese adults: the InterASIA study. Diabetes Res Clin Pract **81**, 250–7.
9) Lohsoonthorn V, Lertmaharit S, Williams MA (2007) Prevalence of metabolic syndrome among professional and office workers in Bangkok, Thailand. J Med Assoc Thai **90**, 1908–15.
10) Park HS, Oh SW, Cho SI, Choi WH, Kim YS (2004) The metabolic syndrome and associated lifestyle factors among South Korean adults. Int J Epidemiol **33**, 328–36.
11) Myong JP, Kim HR, Kim YK, Koo JW, Park CY (2009) Lifestyle and metabolic syndrome among male workers in an electronics research and development company. J Prev Med Pub Health **42**, 331–6.
12) Godefroi R, Klementowicz P, Pepler C, Lewis B, McDonough K, Goldberg RJ (2005) Metabolic syndrome in a screened worksite sample: prevalence and predictors. Cardiology **103**, 131–6.
13) Langenberg C, Kuh D, Wadsworth ME, Brunner E, Hardy R (2006) Social circumstances and education: life course origins of social inequalities in metabolic risk in a prospective national birth cohort. Am J Public Health **96**, 2216–21.
14) Lin YC, Hsiao TJ, Chen PC (2009) Shift work aggravates metabolic syndrome development among early-middle-aged males with elevated ALT. World J Gastroenterol **15**, 5654–61.
15) Demiral Y, Soysal A, Can Bilgin A, Kilic B, Unal B, Ucku R, Theorell T (2006) The association of job strain with coronary heart disease and metabolic syndrome in municipal workers in Turkey. J Occup Health **48**, 332–8.
16) Schultz AB, Edington DW (2009) Metabolic syndrome in a workplace: prevalence, co-morbidities, and economic impact. Metab Syndr Relat Disord **7**, 459–68.
17) Kim Y, Park R, Park W, Kim M, Moon J (2009) Predictors of metabolic syndrome among shipyard workers and its prevalence. Korean J Occup Environ Med **21**, 209–17.

18) Korea Centers for Disease Control and Prevention (2008) The Fourth Korea National Health and Nutrition Examinations Survey (KNHANES IV-I). http://knhanes.cdc.go.kr/ Accessed August 18, 2010.
19) KNSO (2007) Korean standard industrial classification, Vol. 2010. Korea National Statistical Office, Daejeon.
20) Weitzman ER, Folkman A, Folkman MP, Wechsler H (2003) The relationship of alcohol outlet density to heavy and frequent drinking and drinking-related problems among college students at eight universities. Health Place **9**, 1–6.
21) WHO (2004) Appropriate body-mass index for Asian populations and its implications for policy and intervention strategies, Vol. 2009. World Health Organization expert consultation, Geneva.
22) Ryu S, Song J, Choi BY, Lee SJ, Kim WS, Chang Y, Kim DI, Suh BS, Sung KC (2007) Incidence and risk factors for metabolic syndrome in Korean male workers, ages 30 to 39. Ann Epidemiol **17**, 245–52.
23) Kim SG, Lim HS, Cheong HK, Kim CS, Seo HJ (2007) Incidence and risk factors of insulin resistance syndrome in 20–59 year-old Korean male workers. J Korean Med Sci **22**, 968–72.
24) Kang MG, Koh SB, Cha BS, Park JK, Baik SK, Chang SJ (2005) Job stress and cardiovascular risk factors in male workers. Prev Med **40**, 583–8.
25) Griffin JM, Fuhrer R, Stansfeld SA, Marmot M (2002) The importance of low control at work and home on depression and anxiety: do these effects vary by gender and social class? Soc Sci Med **54**, 783–98.
26) Steptoe A, Willemsen G (2004) The influence of low job control on ambulatory blood pressure and perceived stress over the working day in men and women from the Whitehall II cohort. J Hypertens **22**, 915–20.
27) Lee KJ, Um CC, Kim S (2004) Multiple roles of married Korean women: effect on depression. Sex Roles **51**, 469–78.
28) Hwang WJ, Hong O (2012) Work-related cardiovascular disease risk factors using a socioecological approach: implications for practice and research. Eur J Cardiovasc Nurs **11**, 114–26.
29) Hwang WJ, Hong O, Kim MJ (2012) Factors associated with blue-collar workers' risk perception of cardiovascular disease. J Korean Acad Nurs **42**, 1095–1104.
30) Choi ES, Ha Y (2009) Work-related stress and risk factors among Korean employees. J Korean Acad Nurs **39**, 549–61.